

CLAIMS

1. A motor controller comprising:
 - a position detection unit for detecting a position of a motor to be controlled;
 - a speed calculation unit for calculating a speed of the motor from the position of the motor detected by the position detection unit;
 - a speed control unit for performing a speed control, basing on a proportional-integral control by outputting a torque command so that the speed fed back from the speed calculation unit is consistent with a speed indicated by the speed command; and
 - a torque control unit for performing a torque control, basing on the torque command;
- wherein the speed control unit comprises:
- a speed integration compensation low-pass filter having a transfer function corresponding to a delay of a speed control system;
 - an integral control system including a speed integrator, the speed integrator for integrating a speed difference between a speed indicated by a delay speed command and the speed of the motor, the delay speed command being obtained by inputting the speed command into the speed integration compensation low-pass filter;
 - a proportional control system for outputting a command proportional to a difference between the

speed indicated by the speed command and the speed of the motor;

an addition means for adding an output of the integral control system and an output of the proportional control system; and

a multiplication means for multiplying an output of the addition means by a speed proportional gain to produce the torque command.

2. A motor controller comprising:

a position detection unit for detecting a position of a motor to be controlled;

a speed calculation unit for calculating a speed of the motor from a position of the motor detected by the position detection unit;

a speed control unit for performing a speed control, basing on a proportional-integral control by outputting a torque command so that the speed fed back from the speed calculation unit is consistent with a speed indicated by the speed command; and

a torque control unit for performing a torque control, basing on the torque command;

wherein the speed control unit comprises:

a speed integration compensation low-pass filter having a transfer function corresponding to a delay of a speed control system;

an integral control system including a speed

integrator, the speed integrator for integrating a speed difference between a speed indicated by a delay speed command and the speed of the motor, the delay speed command being obtained by inputting the speed indicated by the speed command into the speed integration compensation low-pass filter in the speed control unit, the integral control system multiplying an operand in the integral control system by a speed proportional gain to produce an output;

a proportional control system for producing a command obtained by multiplying the speed proportional gain by a difference between the speed indicated by the speed command and the speed of the motor; and

an addition means for adding an output of the integral control system and an output of the proportional control system.

3. The motor controller according to claims 1 or 2 further comprising a speed feedback low-pass filter having a transfer function that prevents ripples, caused by quantization errors and/or position errors from the position detection unit, from appearing in the torque command;

wherein the proportional control system includes a subtraction means for calculating a difference between

a filtered speed and the speed indicated by the speed command, the filtered speed being obtained by inputting the speed of the motor into the speed feedback low-pass filter.

4. A motor controller comprising:

a current detecting unit for detecting a motor current to be controlled;

a current control unit for outputting a voltage command, basing on a current difference between a current indicated by a current command and a fed-back current based on the motor current detected by the current detector; and

a driving means for supplying the motor current to the motor, basing on the voltage command;

wherein the current control unit comprises:

a delay compensation low-pass filter in the current control unit having a transfer function corresponding to a delay of a current control system;

an integral control system including a current integrator, the current integrator for integrating a current difference between the fed-back current and the current indicated by a delay current command, the delay current command being obtained by inputting the current command into the delay compensation low-pass filter in the current control

unit;

a proportional control system for outputting a command proportional to the current difference between the fed-back current and the current indicated by the current command;

an addition means for adding an output of the integral control system and an output of the proportional control system; and

a multiplication means for multiplying an output of the addition means by a current proportional gain to output the voltage command.

5. A motor controller comprising:

a current detecting unit for detecting a motor current to be controlled;

a current controlling unit for outputting a voltage command, basing on a current difference between a current indicated by a current command and a fed-back current based on the motor current detected by the current detector; and

a driving means for supplying the motor current, basing on the voltage command;

wherein the current control unit comprises:

a delay compensation low-pass filter in the current control unit having a transfer function corresponding to a delay of a current control system;

an integral control system including a current integrator, the current integrator for integrating a current difference between the fed-back current and a current indicated by a delay current command, the delay current command being obtained by inputting the current command into the delay compensation low-pass filter in the current control unit, the integral control system multiplying an operand in the integral control system by a current proportional gain to produce an output;

a proportional control system for outputting a command obtained by multiplying the current proportional gain by the current difference between the fed-back current indicated by the current command; and

an addition means for adding an output of the integral control system and an output of the proportional gain.

6. A motor controller comprising:

a position detection unit for detecting a position of a motor to be controlled;

a speed calculation unit for calculating a speed of the motor from a position of the motor detected by the position detection unit;

a position control unit for performing a position control by outputting a speed command so that the motor

position fed back from the position detection unit is consistent with a position indicated by a position command;

a speed control unit for performing a speed control, basing on a proportional-integral control by outputting a torque command so that the speed fed back from the speed calculation unit is consistent with the speed indicated by the speed command; and

a torque control unit for performing a torque control, basing on the torque command;

wherein the position control unit comprises:

a subtraction means for calculating a position difference between the position indicated by the position command and the position detected by the position detection unit; and

a position loop multiplication means for multiplying the position difference by a position proportional gain;

a differentiator for differentiating the position command;

a feed forward gain multiplication means for multiplying an output of the differentiator by a feed forward gain;

a proportional differentiation means for controlling an output of the feed forward gain multiplication means basing on a proportional differentiation control to compensate a delay of a

speed control system ;

a feed forward low-pass filter having a transfer function for removing ripples caused by quantization errors in the position command, and the feed forward low-pass filter filtering an added value of an output of the proportional differentiation means and an output of the feed forward gain multiplication means; and

an addition means for adding an output of the feed forward low pass filter and an output of the position loop multiplication means to output the speed command.

7. The motor controller according to claim 6, further comprising a delay compensation low-pass filter in the position control unit having a transfer function corresponding to a delay of the speed control system:

wherein the position command is input into the subtraction means through the delay compensation low-pass filter in the position control unit.

8. The motor controller according to claims 6 or 7,

wherein the speed control unit comprises:

a compensation low pass filter in a speed control unit having a transfer function corresponding to a delay of the speed control system;

an integral control system including a speed

integrator, the speed integrator for integrating a speed difference between the speed of the motor and a speed indicated by a delay speed command, the delay speed command being obtained by inputting the speed command into the delay compensation low-pass filter in the speed control unit;

a proportional control system for outputting a command proportional to a difference between the speed indicated by the speed command and the speed of the motor

an addition means for adding an output of the integral control system and an output of the proportional control system; and

a multiplication means for multiplying an output of the addition means by a speed proportional gain to produce the torque command.

9. The motor controller according to claims 6 or 7,

wherein the speed control unit comprises:

a compensation low pass filter in a speed control unit having a transfer function corresponding to a delay of the speed control system;

an integral control system including a speed integrator, the speed integrator for integrating a speed difference between the speed of the motor and a speed indicated by a delay speed command, the delay speed command being obtained by inputting the speed

command into the delay compensation low-pass filter in the speed control unit, the integral control system multiplying an operand in the integral control system by a speed proportional gain to produce an output;

a proportional control system for outputting a command by multiplying a difference, between the speed indicated by the speed command and the speed of the motor, by a speed proportional gain; and

an addition means for adding an output of the integral control system and an output of the proportional control system.

10. The motor controller according to claim 9 comprising;

a position detection unit for detecting a position of a motor to be controlled;

a speed calculation unit for calculating a speed of the motor;

a position control unit for outputting a speed command to control a position so that the motor position fed back from the position detection unit is consistent with a position indicated by a position command;

a speed control unit for outputting a torque command to control a speed, basing on a proportional-integral control so that the speed fed back from the speed calculation unit is consistent with the speed indicated by the speed command; and

a torque control unit for performing a torque control, basing on the torque command;

wherein the position control unit comprises:

a differentiator for differentiating the position command;

a feed forward gain multiplication means for multiplying an output of the differentiator by a feed forward gain;

a proportional differentiation means for controlling an output of the feed forward gain multiplication means, basing on a proportional differentiation control to compensate a delay of a speed control system by;

a feed forward low pass filter having a transfer function for removing ripples caused by quantization errors in the position command, and filtering an added value of an output of the proportional differentiation means and an output of the feed forward gain multiplication means; and

an integrator for integrating a difference between an output of the differentiator and a differential value of the position detected by the position detection unit, to output a position difference;

a position loop multiplication means for multiplying an output of the integrator by a position proportional gain; and

an addition means for adding a command outputted from the position loop multiplication means and a speed feed forward command outputted from the feed forward low pass filter to output the speed command.

11. The motor controller according to claim 10,

wherein the delay compensation low-pass filter in the position control unit having a transfer function corresponding to a delay of the speed control system is arranged between the differentiator and the integrator;

wherein a difference between an output of the differentiator that has passed through the delay compensation low-pass filter in the position control unit and a differential value of the position is inputted into the integrator.